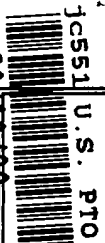


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03/19/98

**UTILITY PATENT  
APPLICATION TRANSMITTAL**(Only for new nonprovisional applications  
under 37 CFR 1.53(b))

Attorney Docket No.

980400

Total Pages

First Named Inventor or Application Identifier

Akira UEDA and Masumi Suzuki

Express Mail Label No.

Check Box, if applicable [ X ] Duplicate

APPLICATION ELEMENTS FOR:

HEAT PIPE TYPE COOLER

ADDRESS TO: Assistant Commissioner for Patents  
BOX PATENT APPLICATIONS  
Washington, D.C. 20231

1. ☒ Fee Transmittal Form (Incorporated within this form)  
(Submit an original and a duplicate for fee processing)
2. ☒ Specification Total Pages [ 12 ]
3. ☒ Drawings (35 USC 113) Total Sheets [ 7 ]
4. ☒ Oath or Declaration Total Pages [ 5 ]
  - a. ☒ Newly executed (original)
  - b. ☐ Copy from prior application (37 CFR 1.63(d)  
(for continuation/divisional with Box 17 completed).
    - i. ☐ Deletion of Inventor(s)  
Signed statement attached deleting inventor(s) named in prior application,  
see 37 CFR 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation by reference (useable if box 4b is checked)  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under  
Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby  
incorporated by reference therein.
6. ☐ Microfiche Computer Program (Appendix)
7. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
  - a. ☐ Computer Readable Copy
  - b. ☐ Paper Copy (identical to computer copy)
  - c. ☐ Statement Verifying identity of above copies

**ACCOMPANYING APPLICATION PARTS**

8. ☒ Assignment Papers (cover sheet and document(s))
9. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☐ Power of Attorney

# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications  
under 37 CFR 1.53(b))

Attorney Docket No.

980400

First Named Inventor or Application Identifier

Akira UEDA et al.

PAGE 2 OF 3

10. ☐ English translation Document (if applicable)

11. ☐ Information Disclosure Statement ☐ Copies of IDS Citations

12. ☐ Preliminary Amendment

13. ☒ Return Receipt Postcard (MPEP 503)

14. ☐ Small Entity Statement(s) ☐ Statement filed in prior application  
Status still proper and desired.

15. ☒ Claim for Convention Priority ☒ Certified copy of Priority Document

a. Priority of Japanese application no. 9-287358 filed on October 20, 1997 is claimed under 35 USC 119.

16. ☐ Other \_\_\_\_\_

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Division ☐ Continuation-in-part (CIP) of prior application no. \_\_\_\_/\_\_\_\_

FEE TRANSMITTAL	Number Filed	Number Extra	Rate	Basic Fee
The filing fee is calculated below				\$790.00
Total Claims	12 - 20	0	x \$22.00	0.00
Independent Claims	2 - 3	0	x \$82.00	0.00
Multiple Dependent Claims			\$270.00	0.00
Basic Filing Fee				\$790.00
Reduction by 1/2 for small entity				0.00
Fee for recording enclosed Assignment			\$40.00	40.00
TOTAL				\$830.00

**UTILITY PATENT  
APPLICATION TRANSMITTAL**

(Only for new nonprovisional applications  
under 37 CFR 1.53(b))

Attorney Docket No.

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First Named Inventor or Application Identifier

Akira UEDA et al.

**PAGE 3 OF 3**

[ X ] A check in the amount of \$830.00 is enclosed to cover the filing fee of \$790.00 and the assignment recordation fee of \$40.00.

[ ] Please charge our Deposit Account No. **01-2340** in the total amount of \_\_\_\_\_ to cover the filing fee and the \_\_\_\_\_ assignment recordation fee. A duplicate of this sheet is attached.

[XX] The Commissioner is hereby authorized to charge payment for any additional filing fees required under 37 CFR 1.16 or credit any overpayment to Deposit Account No. **01-2340**. A duplicate of this sheet is attached.

**18. CORRESPONDENCE ADDRESS**

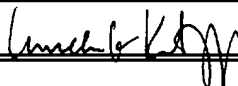
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**SUBMITTED BY**

Typed or Printed Name William G. Kratz, Jr.

Reg. No. 22,631

Signature



Date: March 19, 1998

HEAT PIPE TYPE COOLER

## BACKGROUND OF THE INVENTION

## 5           1.    Field of the Invention

The present invention relates to a heat pipe type cooler.

## 2.    Description of the Related Art

At present, technologically advanced and  
10   miniaturized electronic equipments are appearing. This involves a serious problem of internally generated heat at a high temperature. Use of a heat pipe has been considered and examined for the purpose of efficiently transferring such heat.

15           A heat pipe is a heat-transfer device comprising a sealed metal tube of a generally straight bar shape, with an inner lining of a wicklike capillary material and containing a small amount of fluid (condensed fluid) in a partial vacuum. A heat is  
20   absorbed at one end by vaporization of the fluid and is released at the other end by condensation of the vapor. A heat pipe is characterized by its simple structure and its a high heat transfer rate per unit area, and it can be used in a wide range of temperatures in response to  
25   requirements.

Several examples of a cooling apparatus using heat pipes will be briefly described hereinbelow.

Japanese Unexamined Patent Publication (Kokai) No. 63-254754 discloses a cooling apparatus, having a  
30   straight bar shaped heat pipe, wherein one end of the heat pipe is embedded and fixed in a metal block, and the other end of the heat pipe has on its outer surface a plurality of disc shaped fins, spaced apart and in parallel to each other, and the heat pipe extends through  
35   the centers of the fins.

Japanese Unexamined Patent Publication (Kokai) No. 2-93270 discloses a cooling mechanism comprising

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The primary object of the present invention is,

therefore, to provide a integrally constructed cooler of the heat pipe type, which is free from the aforementioned drawbacks and which ensures the achievement of sufficient cooling capacity and the realization of a simple, compact and in expensive cooler, that is especially low in height, employing and incorporating ingeniously a heat pipe.

To achieve the above object, according to a first feature of the present invention, there is provided a heat pipe type cooler comprising: a heat receiver; a heat radiator; and a heat pipe; and wherein the heat pipe has a generally U or V shaped profile and is secured at its middle portion to the heat receiver and wherein the heat receiver and the hear radiator are thermally connected with the heat pipe.

Preferably, the heat radiator may have a configuration of a plurality of horizontally oriented heat radiation plates extending vertically and wherein each end of the heat pipe passes through the heat radiation plates. Preferably, the heat radiator may have corrugations. Preferably, the heat receiver may have a ridged portion for heat radiation. Preferably, the cooler may further comprise a fastener to secure the heat receiver to a subject to be cooled. Preferably, the cooler may further comprise a connector for another cooler. Further preferably, the connector may comprise a hook portion and a hook engaging portion.

According to another feature of the present invention, there is provided a heat pipe type cooler, comprising: a heat receiver; a heat radiator; and a plurality of heat pipes; and wherein each of the heat pipes has a generally U or V shaped profile and is secured at its middle portion to the heat receiver and wherein the heat receiver and the heat radiator are thermally connected with the heat pipes.

Preferably, the heat radiator may have a configuration of a plurality of horizontally oriented

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heat radiation plates extending vertically and wherein each end of each of the heat pipe passes through the heat radiation plates. Preferably, the heat pipes may be parallelly spaced apart and disposed in a horizontal row.

5 Preferably, the cooler may further comprise a ventilation duct with an inlet and an outlet such that it surrounds the heat radiator. Preferably, the cooler may further comprise a fan interposed between preselected heat pipes.

#### BRIEF DESCRIPTION OF THE DRAWINGS

10 These and other objects of the present invention will become apparent from the following detailed description of the preferred embodiments of the invention in connection with the accompanying drawings.

In the drawings:

15 Fig. 1 is a frontal view showing a heat pipe type cooler of a first embodiment according to the invention;

Fig. 2 is a top view showing the cooler of Fig. 1;

Fig. 3 is a side view showing the cooler of Fig. 1;

20 Fig. 4 is a side view showing the cooler fixed on the LSI;

Fig. 5 is a view showing a cooler including a heat pipe modified;

Fig. 6 is a view showing a cooler in which the heat receiving plate is provided with a rugged portion;

25 Fig. 7 is a view showing a cooler in which the heat radiation plates have corrugations;

Fig. 8 is a view showing a cooler in which two heat radiators are spaced apart, separate from each other;

30 Fig. 9 is a view showing a cooling system comprising coolers interconnected;

Fig. 10 is a view showing a cooler of another embodiment;

Fig. 11 is a top view showing the cooler of Fig. 10;

35 Fig. 12 is a top view showing a modification of the cooler of Fig. 10;

Fig. 13 is a cross-sectional view showing a cooler according to further embodiment; and

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Fig. 14 is a cross-sectional view showing a modification of the cooler of Fig. 13.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention are described hereunder, in detail, with reference to the drawings attached hereto. Common parts in each of the following embodiments are given the same reference characters/numbers, and thus a description thereof is properly omitted, and only parts characteristic of the present invention is mainly described hereunder.

Figs. 1 to 4 show a first embodiment of heat pipe type cooler according to the invention.

With reference to these drawings, the cooler 1 includes a rectangular, heat receiving plate 3 adapted to be fixed to an element (including a heat generator), not shown, intended to be cooled, and also includes a generally U-shaped heat pipe H. Instead, as shown in Fig. 5, a heat pipe H (composing another cooler 1') may have a profile resembling a letter V, the intermediate portion of which being not sharp but round, so as to compose another type of cooler 1'.

As seen in Fig. 1, the intermediate, curved portion of the heat pipe H is fixed to the center on an upper surface of the heat receiving plate 3.

The heat pipe H has upstanding end portions in parallel with each other. Both of the heat pipe end portions pass through a heat radiator 5. The heat radiator 5 has a configuration of a number of (in this embodiment, six) horizontally oriented heat radiation plates (or fins) extending vertically. The heat radiation plates 5 resemble the heat receiving plate 3 in shape.

The heat receiving plate 3 and the heat radiation plates 5 are made of a thermal conductive material, for example, aluminum and are thermally interconnected with the heat pipe H.

The heat receiving plate 3 can be made thin. This

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and other embodiments are described on the assumption that the heat receiving plate 3 may have a thickness of 0.5 mm.

5 The fixation of the heat pipe H to the heat receiving plate 3 is carried out by means of adhesion, soldering, caulking, and etc.

10 In the first embodiment having the above-described structure, as can be seen in Fig. 4, the cooler 1 is placed and secured on a LSI (an example of heat generating elements) by means of a fastener, e.g., by means of a suitable number of C-shaped clips C made of elastic material, such as stainless steel. Instead of such clips as those separate from coolers, the heat radiation plates 5 or the heat receiving plate 3 may be  
15 provided with integrally formed portions (not shown), each of which can perform substantially the same function as that of the C-shaped clip C.

20 The heat generated by the LSI is conducted to the heat receiving plate 3 and is then transferred, through the heat pipe H, most efficiently to the heat radiation plates 5 where the heat is most effectively radiated outside.

25 A thermally conductive member (not shown), such as a flexible sheet made of silicon rubber, a layer of a thermal grease, etc., can be interposed to promote conductivity between the top surface of the LSI and the bottom surface of the heat receiving plate 3. In connection therewith, the thermally conductive member can relieve a stress which may be generated due to a  
30 difference of thermal expansion coefficient between the heat receiving plate 3 and the LSI, and further can absorb or counteract a shock, a jar, or a jolt.

35 Incidentally, as can be seen in Fig. 6, the heat receiving plate 3' can be provided with a ridged portion (including protrusions and recesses) on its top surface so as to widen the surface area thereof to promote heat radiation from the heat receiving plate 3 per se.

As can be seen in Fig. 8, there is provided another type of cooler which comprises a heat pipe H having a generally U shaped profile, the middle portion of which being fixed on a heat receiving plate 3, the end portions of which being upstanding, parallel each other, each being provided with a corresponding heat radiator 5 (5a, 5b) such that it passes therethrough.

Each of the heat radiators 5 has the same configuration wherein it comprises a group of horizontally oriented heat radiation plates 5a, 5b. The two groups of the heat radiation plates are spaced apart, separate from each other, and extend vertically. Further, another provision (not shown) can be made in which radiation plates (of at least one group) have the same tilting angle with respect to the corresponding, upstanding end portion of the heat pipe H.

Cooling units 1" of Fig. 9 each are similar to the cooler 1 according to the first embodiment. Each unit 1" has a heat receiving plate 3", at one end of which is provided a male type projection 7 (as an example of a hook portion according to the invention), at an opposite end of which is provided a female type depression 9 (as an example of a hook engaging portion according to the invention).

35           Unit connection is achieved by engaging a  
projection 7 of one unit with a depression 9 of the other  
unit. By connecting in a series a required number of

units in the same way, a desired large scale cooling system for practical use can be easily and simply constructed.

Referring now to Figs. 10 and 11, another embodiment of the invention will be explained hereinafter. These drawings illustrate a cooler 21 comprising a heat receiving plate 23 and a plurality of heat pipes H (three heat pipes H in this embodiment). Each of the heat pipes H has a generally U-shaped profile, the middle, curved portion of which is fixed on the heat receiving plate 23.

As can be seen in the drawings, the heat pipes H are disposed substantially in parallel and extending generally in a horizontal row.

Each of the heat pipes H has upstanding end portions in parallel with each other which have a heat radiator 25 in a manner that they are passing therethrough.

The heat radiator 25 has substantially the same configuration as that of the above-described first embodiment, i.e., it comprises a number of (in this embodiment, there are six) heat radiation plates 25 disposed in a vertical row with a certain interval therebetween, the plates 25 horizontally extending in parallel with each other such that each end of each of the heat pipes H passes through the heat radiation plates 25.

Supposing that there is an air flow flowing from right hand side to left hand side in Fig. 11, the air may directly collide only with the upstanding heat pipe end portions which are disposed on the upstream side, i.e., right hand side. The air can hardly directly collide with the heat pipe end portions which are disposed on the downstream side, i.e., left hand side.

The heat pipes H can also be arranged such that the heat pipes each are located at a slant with respect to the bottom side of the heat receiving plate 23 (or of the heat radiation plates 25), when viewed from the upper side, as shown in Fig. 12. In this arrangement, the air

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can directly collide not only the upstream heat pipe end portions but also the downstream heat pipe end portions, thereby improving the heat radiation from the heat pipes.

Next, Fig. 13 shows a cooler according to a further embodiment of the invention. The cooler 51 comprises a heat receiving plate 53 and two generally U-shaped heat pipes H fixed on the heat receiving plate 53. The heat receiving plates provided with a heat radiator 55 at their upstanding end portions. The heat radiator 55 comprises a plurality of heat radiation plates 55 (in this embodiment, there are nine), extending horizontally in parallel with each other.

The cooler 51 further comprises a ventilation duct, for example, a square pipe, which surrounds at least the heat radiation plates and has an inlet opening (on the right side) and an outlet opening (on the left side). At the inlet is provided a fan F which may produce a current of air flowing through the duct. Further, as can be seen in Fig. 14, to make a small-sized cooler, another provision can be employed in which a fan F' is interposed between two neighboring heat pipes H.

It is to be understood that the present invention is by no means limited to the specific embodiments as illustrated and described herein, and that various modifications thereof may be made which come within the scope of the present invention as defined in the appended claims.

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CLAIMS

1. A heat pipe type cooler, comprising:  
a heat receiver;  
a heat radiator; and  
5 a heat pipe; and  
wherein the heat pipe has a generally U or  
V shaped profile and is secured at its middle portion to  
the heat receiver and wherein the heat receiver and the  
heat radiator are thermally connected with the heat pipe.
- 10 2. The cooler according to claim 1, wherein the  
heat radiator has a configuration of a plurality of  
horizontally oriented heat radiation plates extending  
vertically and wherein each end of the heat pipe passes  
through the heat radiation plates.
- 15 3. The cooler according to claim 1, wherein the  
heat radiator has corrugations.
4. The cooler according to claim 1, wherein the  
heat receiver has a ridged portion for heat radiation.
- 20 5. The cooler according to claim 1, further  
comprising a fastener to secure the heat receiver to a  
subject to be cooled.
6. The cooler according to claim 1, further  
comprising a connector for another cooler.
- 25 7. The cooler according to claim 6, wherein the  
connector comprises a hook portion and a hook engaging  
portion.
8. A heat pipe type cooler, comprising:  
a heat receiver;  
a heat radiator; and  
30 a plurality of heat pipes; and  
wherein each of the heat pipes has a  
generally U or V shaped profile and is secured at its  
middle portion to the heat receiver and wherein the heat  
receiver and the heat radiator are thermally connected  
35 with the heat pipes.
9. The cooler according to claim 8, wherein the  
heat radiator has a configuration of a plurality of

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horizontally oriented heat radiation plates extending vertically and wherein each end of the heat pipe passes through the heat radiation plates.

5        10. The cooler according to claim 8, wherein the heat pipes are parallelly spaced apart and disposed in a horizontal row.

11. The cooler according to claim 8, further comprising a ventilation duct with an inlet and an outlet such that it surrounds the heat radiator.

10        12. The cooler according to claim 11, further comprising a fan interposed between preselected heat pipes.

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HEAT PIPE TYPE COOLER

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ABSTRACT OF THE DISCLOSURE

To realize a integrally constructed cooler of the  
heat pipe type which ensures the achievement of  
10 sufficient cooling capacity and the realization of a  
simple, compact and inexpensive cooler, that is  
especially low in height, employing and incorporating  
ingeniously a heat pipe, there is provided a heat pipe  
type cooler comprising: a heat receiving plate 3; a heat  
15 radiator having a configuration of a plurality of  
horizontally oriented heat radiation plates 5 extending  
vertically; and a heat pipe H having a generally U or V  
shaped profile, the middle portion of which is secured to  
the heat receiving plate 3: and wherein each end of the  
20 heat pipe H passes through the heat radiation plates 5.

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Fig.1

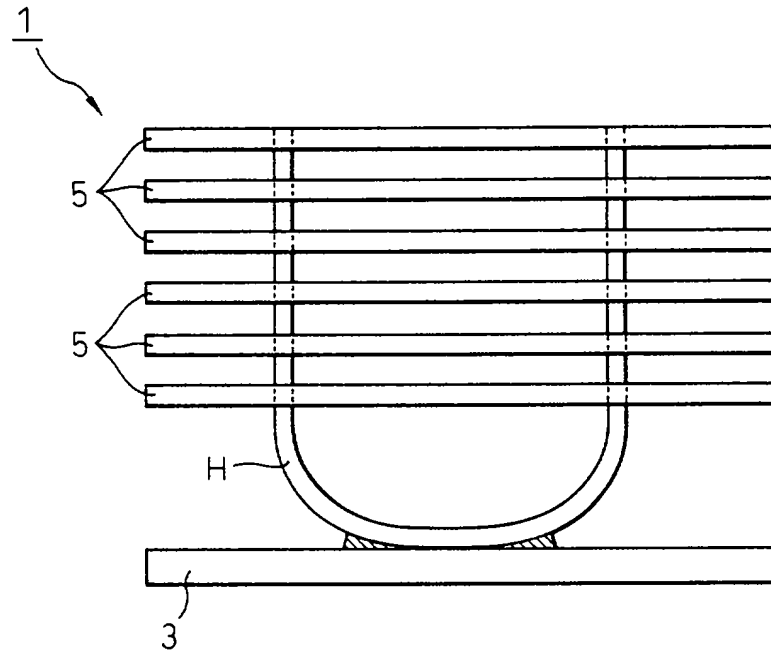


Fig.2

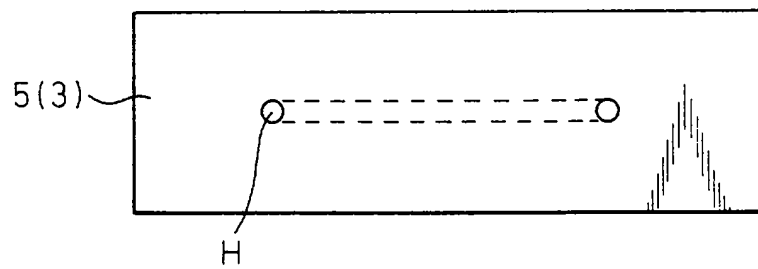




Fig.3

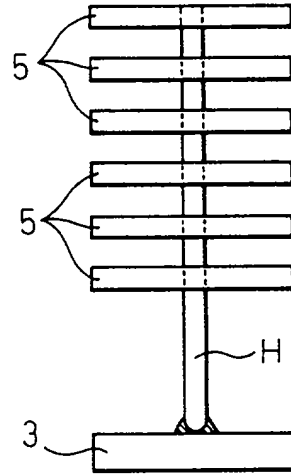


Fig.4

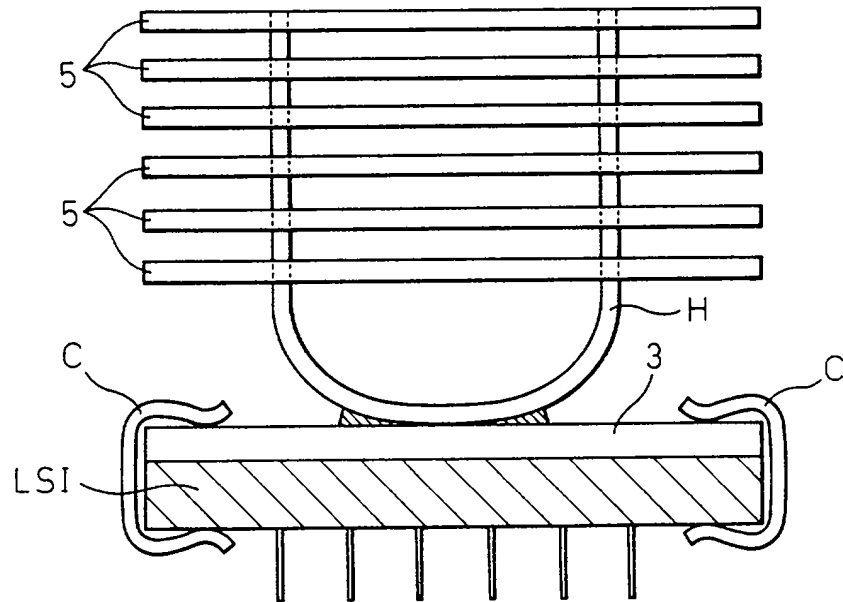


Fig.5

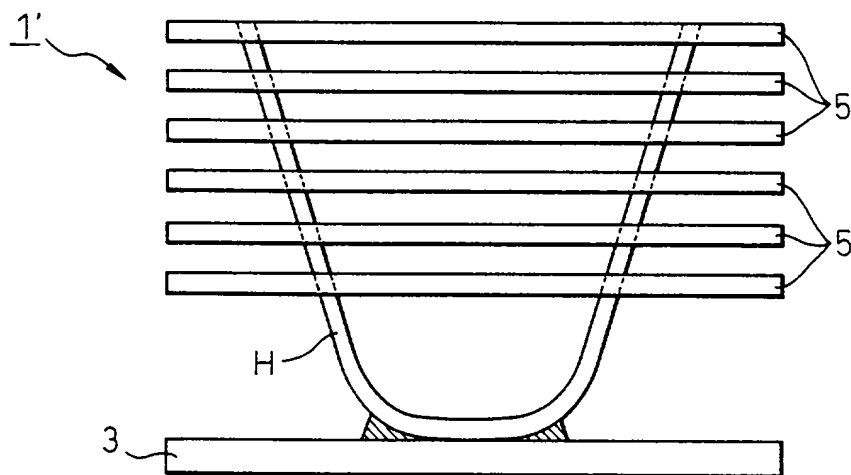


Fig.6

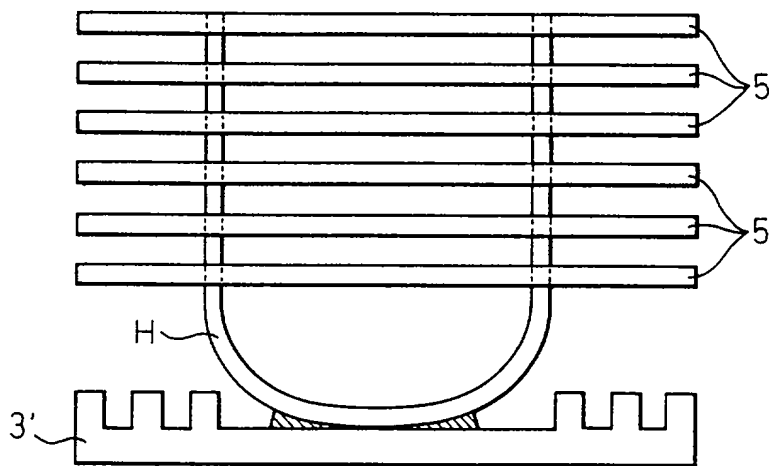


Fig.7

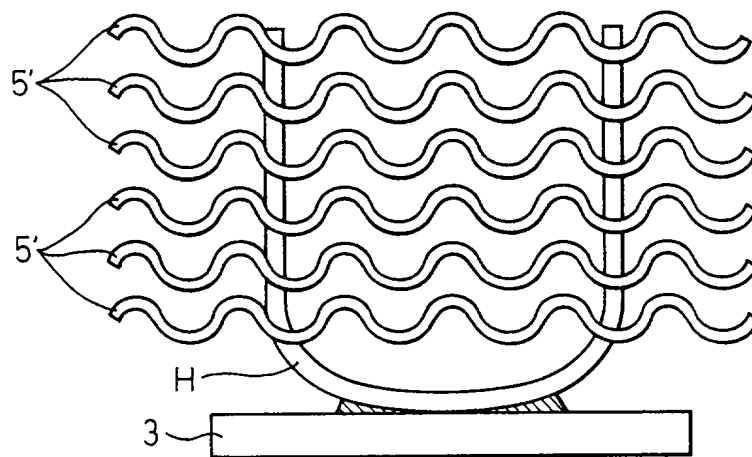


Fig.8

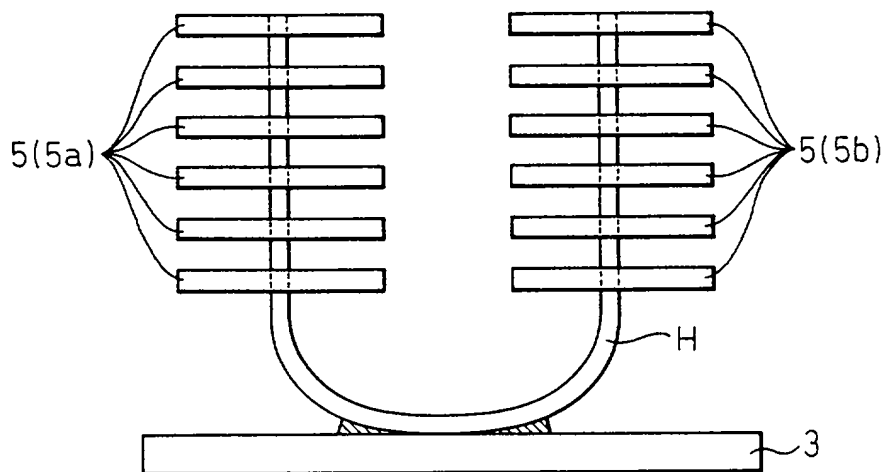


Fig.9

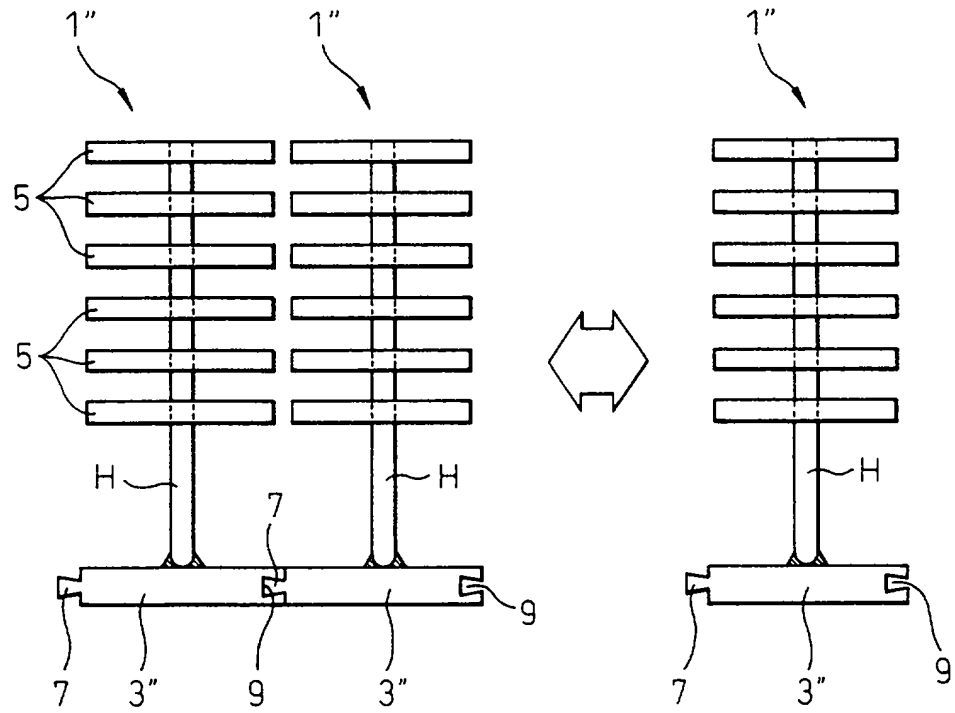


Fig.10

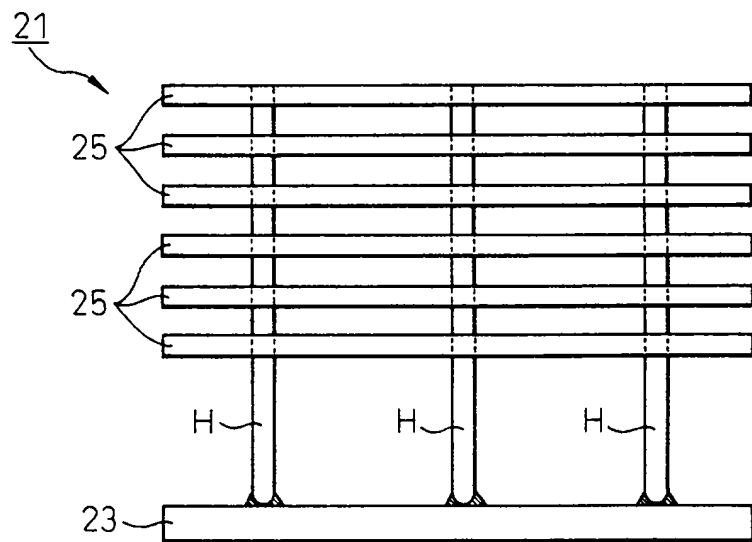


Fig.11

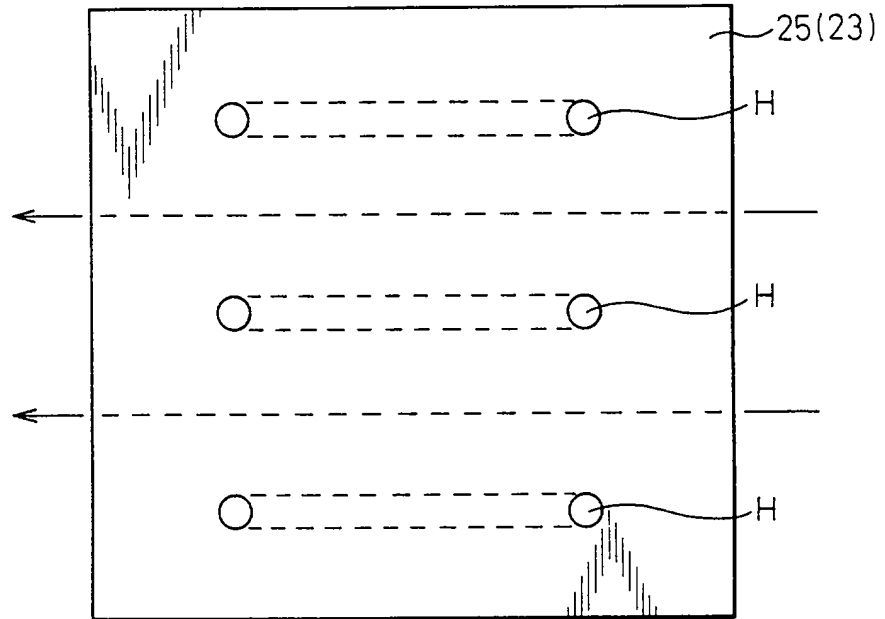


Fig.12

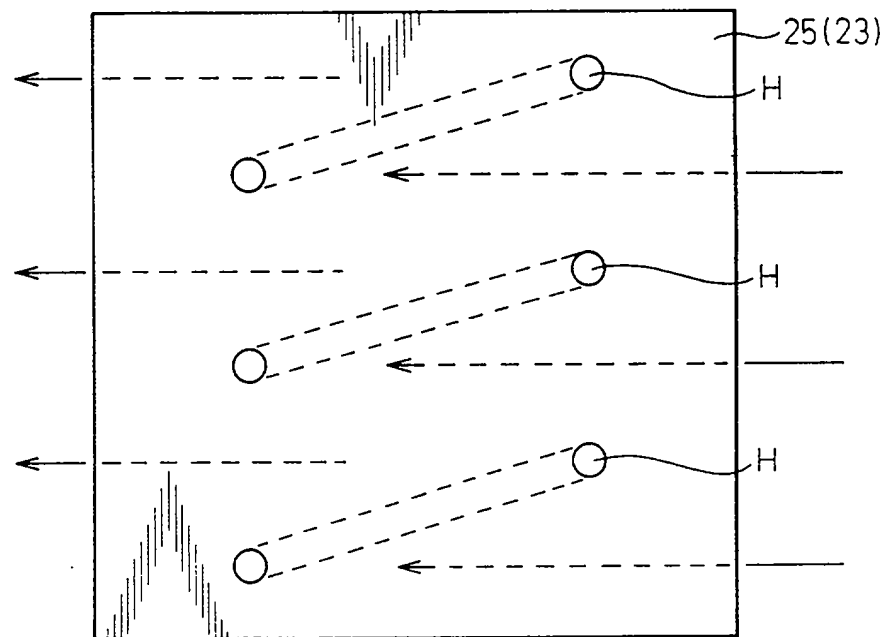


Fig.13

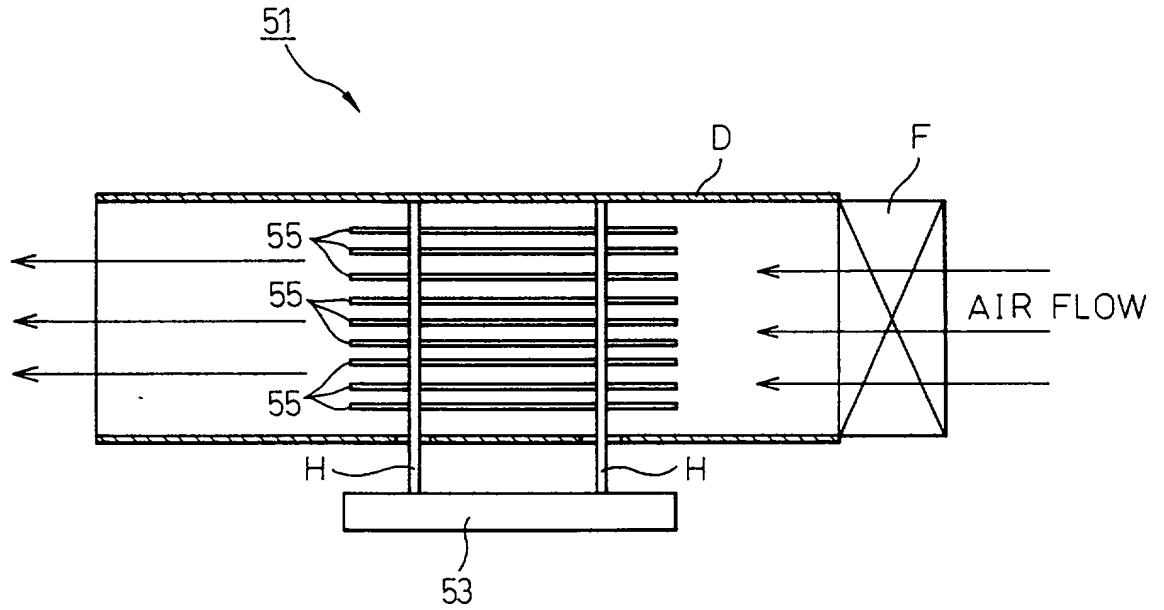
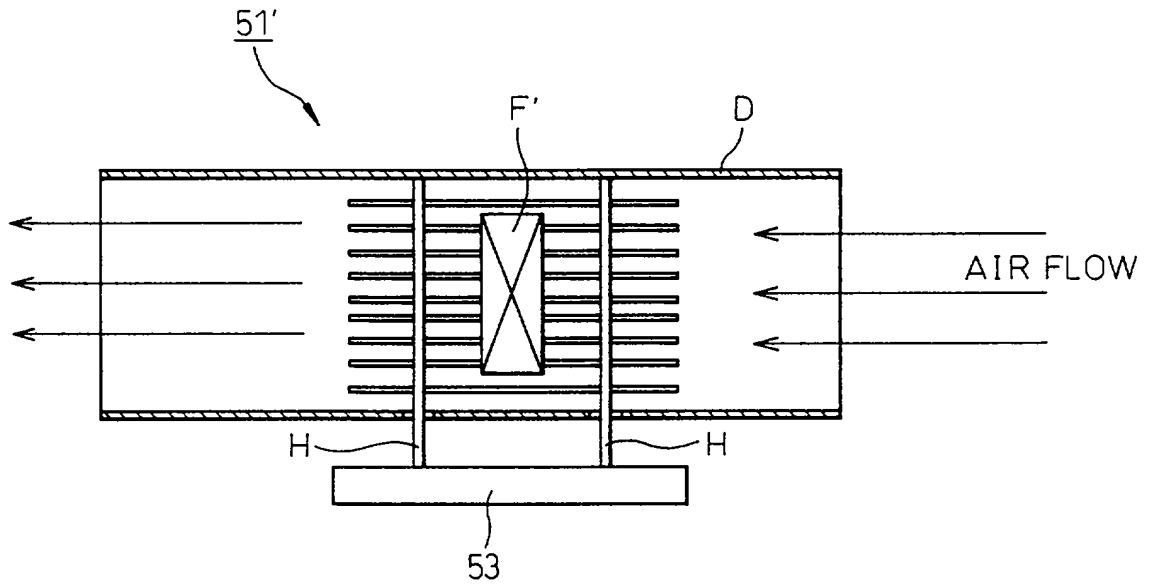


Fig.14



# Declaration and Power of Attorney for U.S. Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HEAT PIPE TYPE COOLER

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を \_\_\_\_\_ とし、  
（該当する場合） \_\_\_\_\_ に訂正されました。

☐ was filed on \_\_\_\_\_  
as United States Application Number or  
PCT International Application Number  
\_\_\_\_\_ and was amended on  
\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されたとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

## Japanese Language Declaration

(日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国外の国の少なくとも一か国を指定している特許協力条約365(a)条に基づき国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

## Prior Foreign Application(s)

外国での先行出願

9-287358(Pat. Appln.)

Japan

(Number)

(Country)

(番号)

(国名)

(Number)

(Country)

(番号)

(国名)

私は、第35編米国法典119条(e)項に基づいて下記の米国外の特許出願規定に記載された権利をここに主張いたします。

(Application No.)

(Filing Date)

(出願番号)

(出願日)

私は、下記の米国法典第35編120条に基づいて下記の米国外の特許出願に記載された権利、又は米国外を指定している特許協力条約365条(c)に基づき権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国外の特許出願に開示されていない限り、その先行米国外出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

(Application No.)

(Filing Date)

(出願番号)

(出願日)

(Application No.)

(Filing Date)

(出願番号)

(出願日)

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I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed

優先権主張なし

☐☐

20/October/1997

(Day/Month/Year Filed)

(出願年月日)

(Day/Month/Year Filed)

(出願年月日)

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)

(Filing Date)

(出願番号)

(出願日)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.



## Japanese Language Declaration

(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁理士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

See list of attorneys and/or agents on page 5.

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